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THE ROLE OF COGNITIVE TRAINING IN ENDOUROLOGY: A RANDOMISED CONTROLLED TRIAL

Authors:

Munuzza Shah[1] BSc (Hons)

Abdullatif Aydin[1] BSc (Hons), MBBS

Aidan Moran[2] BA, MA, PhD, FPsSI, AFBPsS, Reg Psychol., C. Psychol

Muhammad Shamim Khan[1,3] FRCS (Urol), FEBU, OBE

Prokar Dasgupta[1,3] MSc, MD, FRCS (Urol), FEBU

Kamran Ahmed[1,3] MRCS, PhD

Affiliations:

1. MRC Centre for Transplantation, King's College London
2. School of Psychology, University College Dublin
3. Department of Urology, Guy's and St. Thomas' NHS Foundation Trust, London, UK

Correspondence:

Kamran Ahmed MBBS, MRCS, PhD, FRCS (Urol)

NIHR Academic Clinical Lecturer

Specialist Registrar in Urology

King's College London

Guy's Hospital, London

Ph: +44 (0)7939319670

Email: kamran.ahmed@kcl.ac.uk

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CONFLICT OF INTEREST

None declared

ABSTRACT

Introduction

Cognitive training is an important training modality which allows the user to rehearse a procedure without physically carrying it out. This has led to recent interests to incorporate cognitive training within surgical education but research is currently limited. The use of cognitive training in surgery is not clear-cut and so this study aimed to determine whether, relative to a control condition, the use of cognitive training improves technical surgical skills on a ureteroscopy simulator, and if so whether one cognitive training method is superior.

Methods

This prospective, comparative study recruited 59 medical students and randomised them to one of three groups: control- simulation training only (n=20), flashcards cognitive training group (n=20) or mental imagery cognitive training group (n=19). All participants completed three tasks at baseline on the URO Mentor simulator followed by the cognitive intervention if randomised to receive it. Participants then returned to perform an assessment task on the simulator. Outcome measures from the URO Mentor performance report was used for analysis and a quantitative survey was given to all participants to assess usefulness of training received.

Results

This study showed cognitive training to have minimal effects on technical skills of participants. The mental imagery group had fewer laser misfires in the assessment task when compared to both control and flashcards group (p=0.017,0.036 respectively). The flashcards group rated their preparation to be most useful when compared to control (p=0.0125). Other parameters analysed between the groups did not reach statistical significance. Cognitive training was found to be feasible and cost effective when carried out in addition to simulation training.

Conclusion

This study has shown that the role of cognitive training within acquisition of surgical skills is minimal and that no form of cognitive training was superior to another. Further research needs to be done to evaluate other ways of performing cognitive training.

INTRODUCTION

Surgeons have always required many years of training to develop the fine motor skills required to carry out procedures to perfection. These skills require varying times to reach competency and skills were traditionally gained through an unstructured apprenticeship model (1). In recent years, this has been limited due to various reasons including working time restrictions such as the European working time directive and advances in technology, which have made technical skills more complex (2). Simulation has gained wide acceptance within training programmes, especially in urology (3). However, access to simulators is not always guaranteed due to cost and availability. Thus, surgeons and trainees are always looking at supplementary methods of gaining skills for safe practice (4). Cognitive training is a well-established tool in the fields of sports, music, psychology, education and medicine, all professions of which require continued rehearsal (5).

Cognitive training has a variety of different forms, the most studied of which is mental imagery, the ability to 'see' and 'feel' an activity without physically carrying it out (6). The use of cognitive training in surgery has been a recent interest and studies carried out have shown conflicting results to its usefulness (4). Cognitive training methods have also not been compared in any previous studies and so adopting the most suitable form of cognitive training remains a challenge in surgical training. Therefore, this study aims to determine whether 1) relative to a control condition, the use of cognitive training improves technical surgical skills on a ureteroscopy simulator and 2) whether one cognitive training method is superior to another.

MATERIALS AND METHODS

Study Design

This prospective, randomised controlled study compared two methods of cognitive training; flashcards and mental imagery, relative to a control group (Figure 1). Medical students without prior ureteroscopy experience (n=59) were recruited and randomised to one of three study groups, using block randomisation to ensure groups of equal sizes. All participants received a 20-minute didactic teaching session which introduced them to ureteroscopy, the simulator (URO Mentor, Simbionix, Cleveland, OH, USA) and all the equipment. During the session, a distal ureteric stone case was also demonstrated on the simulator. Following the didactic session all participants were given ample time to practice by performing two basic tasks on the simulator and the same distal ureteric stone case that was demonstrated.

Those in the control group received no further training. Those in the flashcards group and mental imagery group underwent their interventions (Figure 1). The flashcards group were given a set of flashcards which covered all the nodal points of the distal ureteric stone case (Figure 2). The participants went through the flashcards both alone and with a mentor, who used error based learning to cover common pitfalls and answer any questions.

Participants in the mental imagery group were given the mental imagery script produced for familiarisation of the procedure. The script was based on previous studies which used mental imagery (7-9) and included visual, kinaesthetic and cognitive cues. After familiarisation, a mentor used breathing techniques to help participants relax and clear their minds, after which the participants were taken through the script encouraging them to imagine carrying out the procedure.

All participants were re-invited to perform a mid-ureteric stone case as an assessment task. A mid-ureteric stone was chosen as the procedure and equipment used was the same as for the distal-ureteric stone but the case was slightly more difficult, allowing students to apply the skills they have gained in an unfamiliar task. This allows us to see if initial training can be extrapolated across different cases. All participants were then given a quantitative questionnaire, with the mental imagery group receiving additional questions, adapted from previous studies (supplementary material) (10, 11).

Outcome Measures

Several outcome measures produced by the URO Mentor as part of the performance report were used for analysis (Table 1-2). Trauma from the scope was defined as any direct hit of the scope on to the urethra, bladder or ureter and laser misfires was defined as the percentage of time the laser was fired at something other than the stone being fragmented. Secondary outcome measures were extracted from the post study questionnaire to assess usefulness of simulation teaching, how prepared they felt for the assessment task, how difficult the tasks were and how confident they felt in carrying out a future ureteroscopy case. The mental imagery questionnaire assessed the usefulness of the mental imagery training by looking at how easy it was to visualise the procedure, how easy it was to feel the procedure, how clear and vivid the images were in their mind and if the participants would be able to talk someone else through the steps of the procedure.

Statistical Analysis

The performance report produced by the URO Mentor simulator was exported and tabulated on to Microsoft Excel (Microsoft Corporation, Washington, DC, USA). The data was analysed using GraphPad version 6.0 (Prism, La Jolla, CA, USA). Demographic analysis was done using a one-way ANOVA to see if there were any differences between the groups. Analysis of all study parameters and post study questionnaires was done using non-parametric Mann Whitney-U tests. Graphs were produced for all parameters and a p value of <0.05 was considered statistically significant.

RESULTS

This study recruited 59 medical students from medical schools across London, 52 of whom completed the study. Time between session 1 and 2 varied, median time being 10 days after sessions 1 (range 5-21 days). No statistical significance was observed between the three different study groups with regards to age, year group, operating room experience, number of ureteroscopy cases observed and number of times assisted in surgery (table 3). A power calculation was performed using an alpha of 0.05 which showed that with a sample size of at least 51 students, a significant difference between the study groups can be demonstrated with a power of >80%.

Simulator Metrics

At baseline 3 different tasks were carried out by all participants: bladder inspection, ureteral orifice catheterisation, and distal ureteric stone case. There was no statistical significance upon comparison of outcome parameters between the different groups. A mid-ureteric stone case was carried out at assessment by all participants who completed the study. Intragroup analysis (Table 4) showed statistical significance in favour of mental imagery for laser misfires (% of total) when compared to both control and flashcards p=0.017, p=0.036 respectively (Figure 3). No other parameters reached statistical significance when compared between the study groups.

Evaluation Survey

All participants agreed that the baseline practice session on the URO Mentor was useful, scoring an average of 9.19 on a 10-point rating scale. On average, the tasks at baseline were rated as 6.37 for difficulty whereas the assessment task was rated as 6.04. All three study groups felt prepared for the assessment task with the flashcards group feeling most prepared and compared to the control group this was statistically significant (flashcards = 8.88, control = 7.89, p = 0.0125). All three groups felt confident in performing another ureteroscopy case, (average 7.48/10).

The mental imagery group had four extra questions which assessed the usefulness of the mental imagery process. The questions looked at how easily the participants could ‘see’ the procedure, how vivid the images were in their mind, how easily they could ‘feel’ the procedure and if they would be able to talk someone through the steps of a ureteroscopy case. The mean response to each of these questions were 7.71/10, 7.9/10, 6.7/10 and 7.7/10 respectively showing that the participants were able to visualise and mentally rehearse the procedure well.

DISCUSSION

Cognitive training has been successfully implemented for surgical skills training in previous studies alongside physical practice, usually on a simulator. It has also been incorporated in a curriculum based training programme and showed superior results, demonstrating that cognitive training can be part of a structured training programme for surgeons (12). The different types of cognitive training have shown promising results especially the use of mental imagery. The cost of cognitive training is minimal when compared to the cost of using a high fidelity simulator and once resources for the use of cognitive training have been produced (mental imagery script, flashcards etc) and participants are familiar with the process, they can practice alone without a mentor, bringing the cost down to zero.

The current study compared two different methods of cognitive training against a control which received no additional training. Most of the results did not reach statistical significance showing that between the three groups there was no difference in surgical technical skills. At baseline, two tasks and one case was carried out and analysis for all the metrics produced from these was analysed and no statistical significance was found. This showed that at baseline all participants began at the same level and no group had an advantage over another.

Comparison of the case performed at assessment showed the mental imagery group to have fewer laser misfires (% of total) when compared to both the controls and to the flashcards group, p=0.017, 0.0136 respectively (table 4). This was the only parameter to reach statistical significance in the comparison of the assessment task and shows that the mental imagery group had more control over the use of the laser and could focus it on to the stone without causing damage to the ureter. Clinically this would mean that those who had undergone MI training would have more control over the laser equipment and would have less ureteral damage. Other important metrics produced by the URO Mentor did not differ significantly between the groups showing that overall, the performance of the three groups was similar.

In previous studies cognitive training has shown promising results if carried out with a mentor and sufficient time has been dedicated to it. Previous studies which reached statistical significance in favour of mental imagery usually had a few short sessions of mental imagery or a longer session, usually 30 minutes (7, 13, 14). Participants in some previous studies have also been encouraged to rehearse mentally alone in between the baseline and assessment sessions (9). In this study the mental imagery lasted in total 20 minutes with an additional 10 minutes for the participants to first familiarise themselves with the script. The MI session was kept short as the participants were all able to recall the steps quickly having just practiced on the URO Mentor and in future studies possibly giving a break between the practice and intervention would be useful to allow for longer intervention sessions. There were no repeats and individual rehearsal was not encouraged to ensure all participants had the same length of intervention. This could explain the lack of statistical significance seen between the groups.

Only one previous study has looked at the use of flashcards (operation primer) but it was coupled with mental imagery rehearsal (8). We coupled the operation primer with error based learning which has been used in two previous studies but on both occasions, did not reach statistical significance (15, 16). The coupling of the flashcards with error based learning did not in this case lead to an improvement in technical skills compared to the control.

Results from the questionnaire show that all participants felt confident in carrying out the procedure and felt prepared to perform the assessment task, although the flashcards group was shown to be significantly more prepared than the control, $p=0.0125$. This shows that although the performance of the flashcards group was not superior to the controls, they felt more prepared and this is due to the cognitive intervention that was given to them. No other parameters in the study was shown to be statistically significant.

As with any study there are limitations to the current study which could explain the lack of statistical significance seen. One of the problems encountered was damage to the semi-rigid ureteroscope by a participant towards the end of the study. It was not possible to replace the ureteroscope for the remaining few days and as it was still functional the remaining participants could use it. This could have led to participants who used the scope after damage to be slower and could be a possibility as to why no difference between the groups was seen.

Other possible reasons include the fact that the time between baseline and assessment was not kept constant for participants due to students having difficult schedules which could have given those students who came back sooner an advantage. The cognitive training carried out was probably not done for enough time as previous studies have shown a minimum of 30 minutes is needed to show educational benefit and repeats or individual rehearsal should have been encouraged.

Medical students were recruited for the current study to ensure all participants were inexperienced and any differences seen in the assessment task were due to the intervention and not from previous exposure. This is also a limitation as the medical students do not have any previous experience to compare to when answering the post study questionnaire. The study could have benefitted from a larger number of participants to more clearly differentiate between the groups and to give more power to the study. The questionnaire was not previously validated but remains a good indicator of what the students perceived as useful regarding the different aspects of training given.

Further research should be carried out to compare different combinations of cognitive training using repeated sessions and looking at the effects on experienced participants such as surgical trainees and consultants.

CONCLUSIONS

The current study compared two different cognitive training methods relative to a control and found cognitive training to have little effect on the acquisition of technical skills within novices. This could be due to various reasons including not having sufficient training time with the cognitive training interventions. Although the study did not demonstrate any group to be superior, it did show that the mental imagery group could use the laser instruments more carefully and the flashcards group felt most prepared to carry out the ureteroscopy procedure. All groups perceived the training to be useful and all participants felt confident about the task. Feasibility of cognitive training was demonstrated and cost effectiveness compared to simulation based training was also shown.

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FIGURE LEGENDS

Figure 1 – study protocol. Lost to follow up (n=2). Excluded from analysis due to technical error (n=5).

Figure 2 – flashcard showing one of the key steps in the ureteroscopy procedure along with a warning sign

Figure 3 – Comparison of Laser Misfires comparison for all three study groups from assessment task, mid ureteric stone case. Abbreviations: MI - Mental Imagery

TABLES

Table 1 – Intragroup comparison of performed basic tasks

Parameters	Control (C)	Flashcards (F)	Mental Imagery (M)	P Value (C vs F)	P Value (C vs M)	P Value (F vs M)
Bladder Inspection						
Time (secs)	415.02	369.16	337.07	0.935	0.568	0.413
Trauma (no.)	3.61	3.06	2.47	0.980	0.423	0.382
Ureteral Orifice Catheterisation						
Time (secs)	260.40	212.09	218.03	0.184	0.387	0.634
Trauma (no.)	1.44	1.06	1.47	0.136	0.943	0.123
Catheterisation (secs)	151.32	105.00	102.94	0.124	0.228	0.946

Table 2 – Intragroup comparison of the important metrics produced by the URO Mentor for distal ureteric stone case

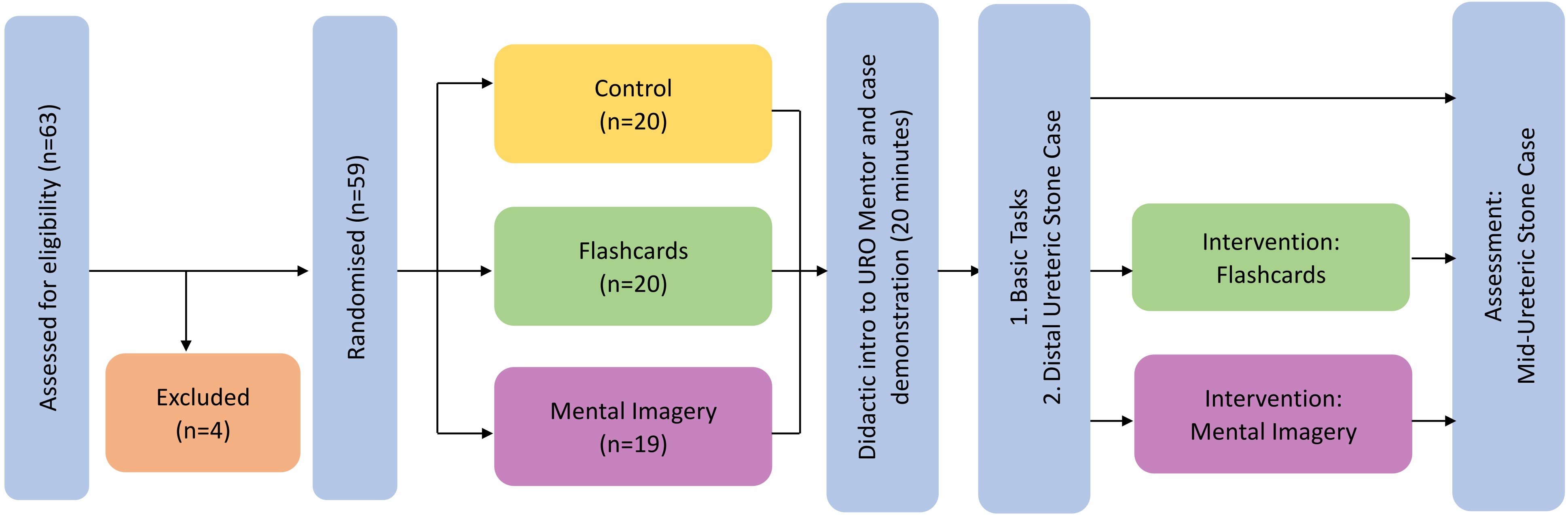
Parameters	Control (C)	Flashcards (F)	Mental Imagery (M)	P Value (C vs F)	P Value (C vs M)	P Value (F vs M)
Time (secs)	1006.56	986.61	1043.20	0.807	0.782	0.946
Trauma (no.)	8.61	10.94	10.12	0.099	0.297	0.351
Catheterisation (secs)	62.45	23.14	29.63	0.136	0.568	0.122
Catheterisation (attempts)	7.67	3.47	4.24	0.117	0.524	0.236
Fragmentation time (secs)	20.10	20.60	20.30	0.981	0.530	0.616
Total Laser Energy (W)	182.00	181.35	161.59	0.916	0.573	0.714
Laser Misfires (% of total)	8.67	6.85	0.83	0.984	0.142	0.133
Maximal Extracted stone (mm)	7.96	7.81	7.97	0.091	0.702	0.083
Maximal Residual stone (mm)	7.45	6.29	7.53	0.981	0.690	0.993
X-Ray Exposure time (secs)	2.32	3.47	4.26	0.813	0.763	0.993

Table 3 – Demographics of participants who completed the study. Abbreviations: OR- operating room, URS- ureteroscopy

	Control	**Flashcards**	**Mental Imagery**
n	18	17	17
Age (mean)	21.1	21.4	21.6
Year Group (mean)	2.3	2.3	2.9
OR Attendance (n)	8.6	7.6	9.9
URS observed (n)	1	0.4	0
Assisted Operations (n)	0.5	0.8	2.1

Table 4 – Intragroup comparison of the important metrics produced by the URO Mentor for mid ureteric stone case

Parameters	Control (C)	Flashcards (F)	Mental Imagery (M)	P Value (C vs F)	P Value (C vs M)	P Value (F vs M)
Time (secs)	1056.52	977.42	947.53	0.523	0.636	0.892
Trauma (no.)	10.50	12.18	8.47	0.737	0.187	0.160
Catheterisation (secs)	63.20	23.82	51.27	0.437	0.877	0.545
Catheterisation (attempts)	8.61	3.47	7.47	0.169	0.980	0.136
Fragmentation time (secs)	36.69	40.78	41.49	0.276	0.241	0.885
Total Laser Energy (W)	324.78	340.41	338.00	0.607	0.726	0.344
Laser Misfires (% of total)	8.18	4.36	1.98	0.760	**0.017**	**0.036**
Maximal Extracted stone (mm)	4.97	5.14	4.83	0.356	0.248	0.097
Maximal Residual stone (mm)	4.21	3.90	3.61	0.903	0.529	0.726
X-Ray Exposure time (secs)	2.61	2.07	2.67	0.654	0.877	0.766



Assessed for eligibility (n=63)
Excluded
(n=4)
Randomised (n=59)
Control
(n=20)
Flashcards
(n=20)
Mental Imagery
(n=19)
Didactic intro to URO Mentor and case demonstration (20 minutes)
1. Basic Tasks
2. Distal Ureteric Stone Case
Intervention:
Flashcards
Intervention:
Mental Imagery
Assessment:
Mid-Ureteric Stone Case

Figura (Figure 2)

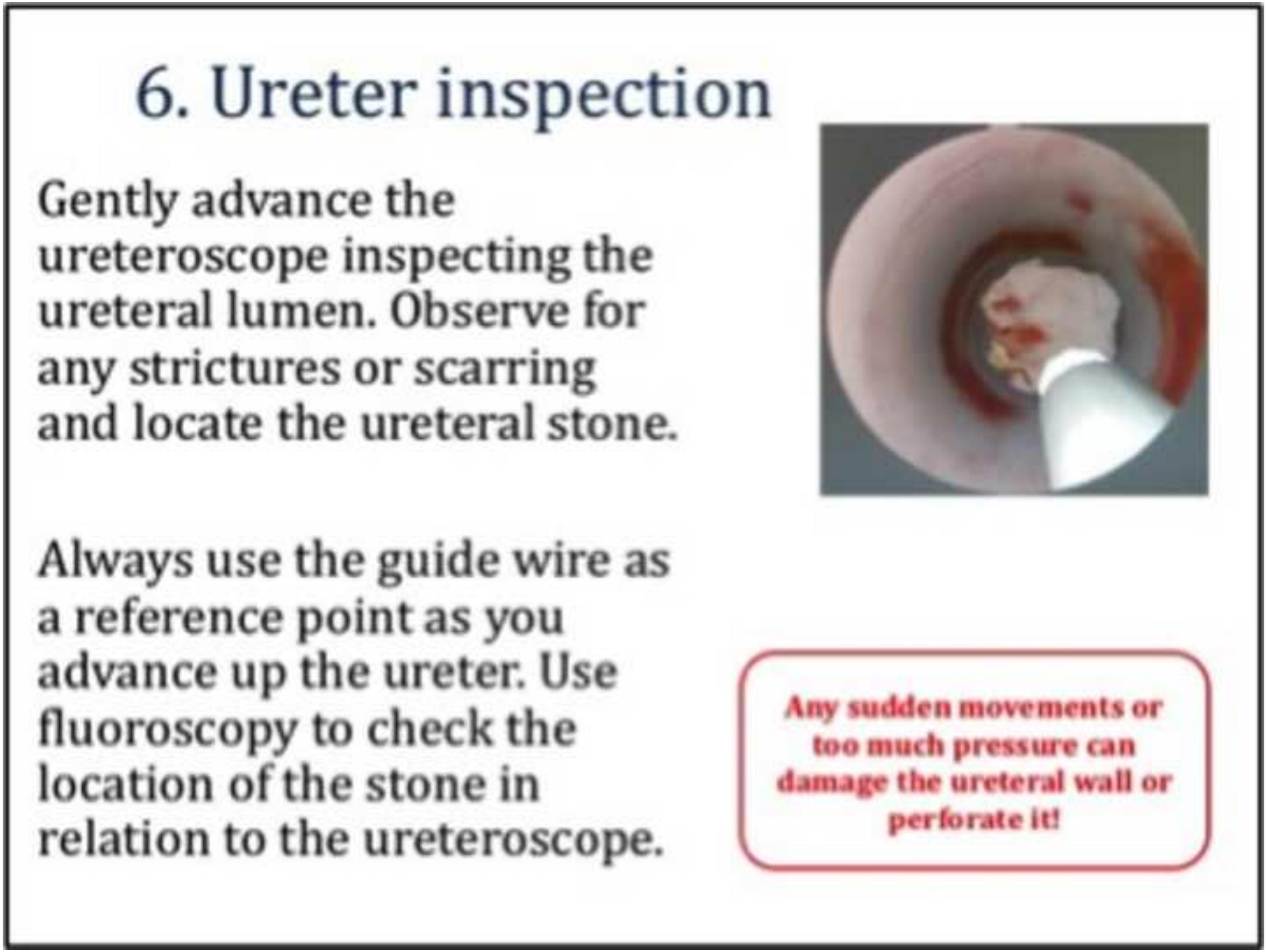


Figura (Figure 3)
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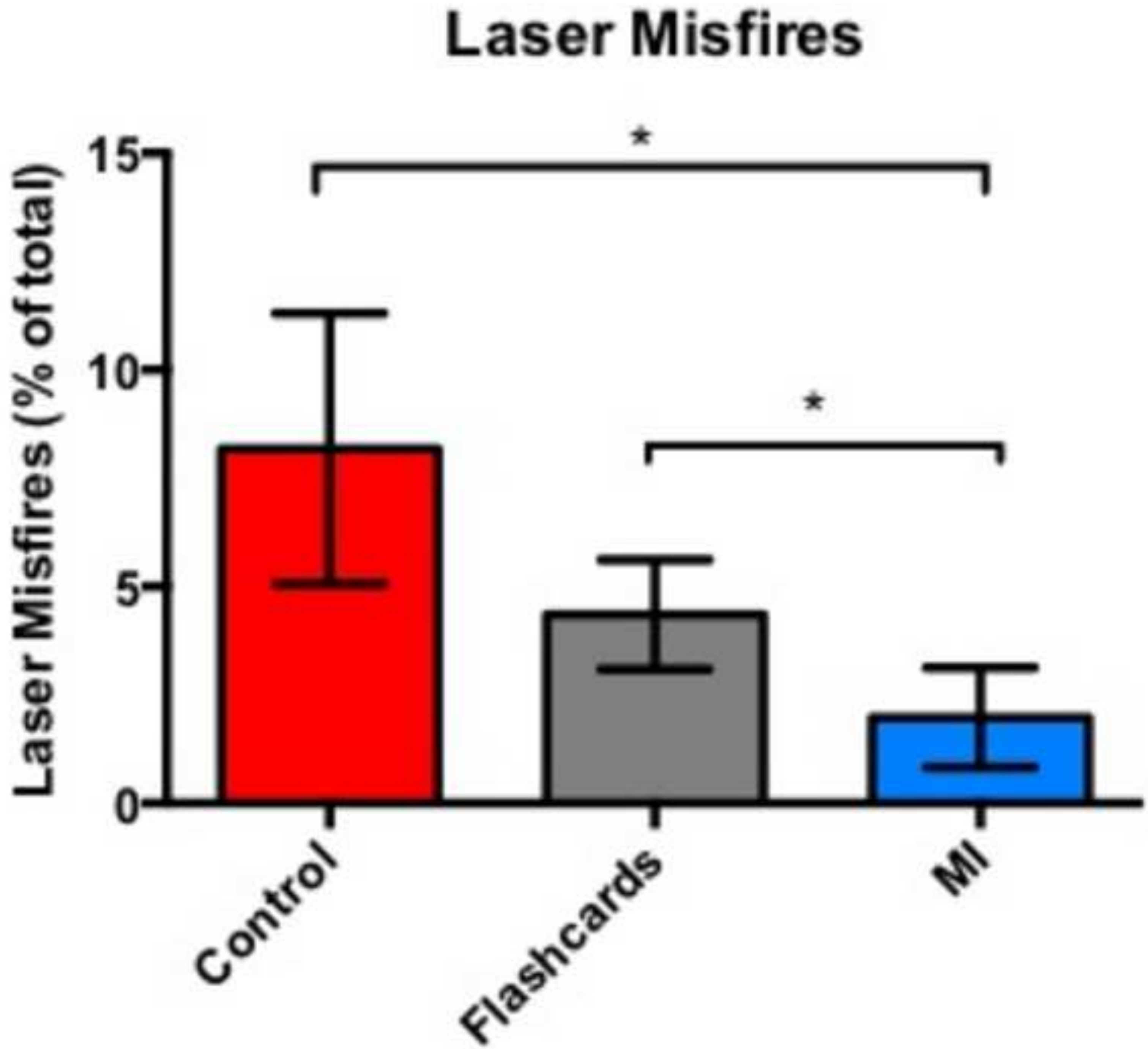

Suppl. Questionnaire

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